APPENDIX M

TECHNICAL MEMORANDUM REGARDING ELEVATED ALPHA SURFACE ACTIVITY

Technical Memorandum

To:	Hamide Kayaci, RPM, HPNS
From:	Ed Palser
Date:	September 23, 2014
Subject:	Technical Approach: Elevated Alpha Surface Activity on Weathered Outdoor Metal Surfaces; Parcel D-1 Phase II Radiological Remediation and Support, Hunters Point Naval Shipyard
Contract/TO:	N62473-10-D-0808, CTO-0004 **Navy DCN:** ITSI-0808-0004-0032

In performing radiological surveys of ship berths at HPNS, Gilbane has encountered elevated alpha activity in the range of 100 to 400 dpm/100 cm^2 on the surfaces of various weathered outdoor metal surfaces, particularly pier components, which cannot be readily explained by radon and is not suspected to be due to contamination. The release criterion for ship berth-related alpha activity is 100 dpm/100 cm^2.

Background

The *Historical Radiological Assessment* determined that the ship berths at HPNS were radiologically impacted primarily as the result of Operation Crossroads decontamination efforts and secondarily due to the possibility of radium devices existing in the area. The radionuclides of concern for the ship berths are Sr-90, Cs-137, Ra-226, and Pu-239. Of particular interest here are the alpha-emitting radionuclides of concern Ra-226 and Pu-239. For simplicity in execution, residual radioactivity on structure surfaces measured as gross alpha activity is assumed to be either Ra-226 or Pu-239, unless isotopic analysis is performed or a technical basis for an alternate approach is documented and approved for use by the Navy. Based on this assumption, the measured alpha activity on the pier components exceeds the release criterion for alpha activity.

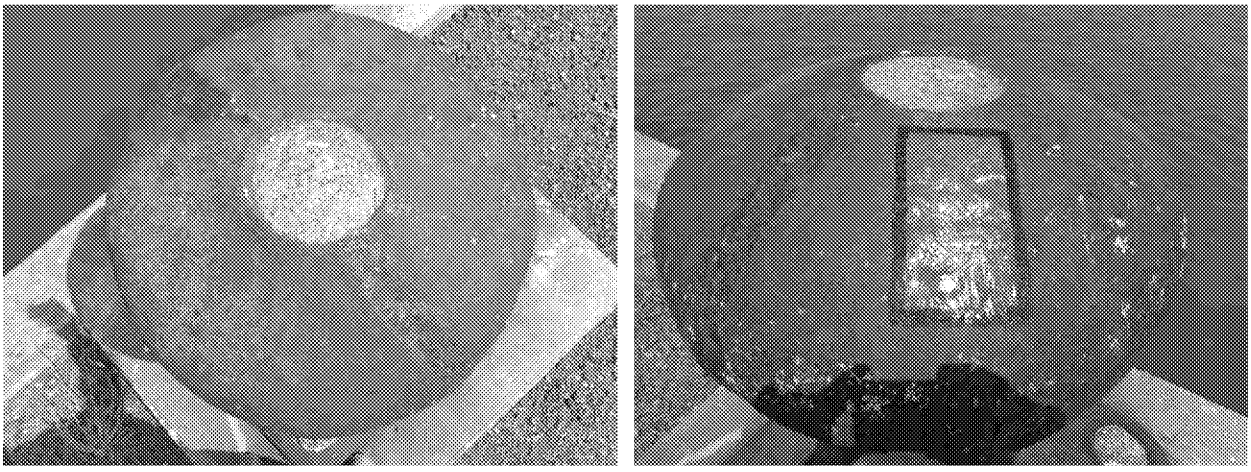
Elevated alpha activity has been found consistently on or near heavily weathered (i.e., rusted) metal surfaces. This same issue has been encountered and studied by previous contractors; however, no resolution was achieved. Previous studies have ruled out radioactive contamination from Ra-226 or Pu-239, radon accumulation/build-up, and removable surface activity as the source of the elevated alpha activity. It has been suspected to be the result of a paint component or a physical phenomenon such as static charge build-up from wind. Regardless, no definitive answer has been developed as to the source of the elevated alpha surface activity and how it should be handled.

Research has identified another possible source of elevated alpha activity as electrostatic charge attracting radon progeny, specifically Po-210. The plate-out of Po-210 on outdoor metal structures has been confirmed at several DOE sites. The Po-210 deposition is readily observable primarily on galvanized metal surfaces or metal that is rusty, oxidized, or weathered and is possibly due to an electrostatic charge. Other radon progeny does not appear to adhere and accumulate the same as Po-210.

Method

Building upon previous studies, Gilbane collected samples of metallic shavings, rust particles and paint scraped from four bollards located at Ship Berth 14. Scrapings were collected from a 100 cm^2 area of elevated alpha activity (i.e., ranging from 200 to 400 dpm/100 cm^2) on the top of each bollard. Figure 1 shows a representative bollard from Ship Berth 14 before and after a sample of scrapings is collected.

Figure 1 – Photo of Representative Bollard Before and After Scraping Sample Collected



Measurements of total alpha surface activity were taken before and after each scraping was collected to verify the alpha activity was captured in the scrapings themselves (see attached radiological survey). The measurements are summarized in Table 1. Surface measurements were taken with a Ludlum Model 43-93 100-cm^2 zinc sulfide (silver activated) dual phosphor scintillation detector coupled to a Ludlum Model 2360 alpha/beta dual-channel scaler.

Table 1 – Total Alpha Surface Activity Measurements

Sample Location	Alpha Activity (dpm/100 cm^2)	
	Before Sampling	After Sampling
Bollard #1	218	23
Bollard #2	251	17
Bollard #3	264	17
Bollard #4	348	23

The scrapings from the four bollards were combined into a single composite sample. The sample was sent to ARS International, LLC, in Port Allen, Louisiana, for analysis. ARS is accredited under the DoD Environmental Laboratory Accreditation Program and the CDPH National Environmental Laboratory Accreditation Program. Five types of analyses, listed in Table 2 below, were performed.

Table 2 – Laboratory Sample Analyses

Analytical Method	Method Number
Gamma Spectroscopy	ARS-007/EPA 901.1M
Gross Alpha/Beta	ARS-003/EPA 900.0M
Isotopic Pu by Alpha Spectroscopy	ARS-026/Eichrom ACW-03
Po-210 by Alpha Spectroscopy	ARS-034/HASL-PO-01 RC
Sr-90 by Gas Flow Proportional Counting	ARS-032/Eichrom SRW01

Discussion of Results

The laboratory analytical results (see attached laboratory report) are summarized in Table 3. Radionuclides listed with no reported activity were not detected as present in a concentration above the sample MDC. K-40 is naturally occurring and is found throughout nature wherever there is potassium. Be-7 is formed in the atmosphere and deposits onto the earth's crust. The presence of both Cs-137 and

Sr-90 in the sample is not necessarily indicative of contamination from legacy Navy operations. Both are fission products that are routinely encountered in the environment as a result of the atmospheric testing of nuclear weapons. The ratio between the Be-7, and Cs-137 and Sr-90 are consistent with background levels associated with the aforementioned atmospheric testing of nuclear weapons. Pb-210 and Pb-214 are progeny of Rn-222. Pb-214 is minutes removed from the decay of Rn-222 and Pb-210 with its 22 year half-life, once present, dissipates slowly.

Table 3 – Laboratory Analytical Results

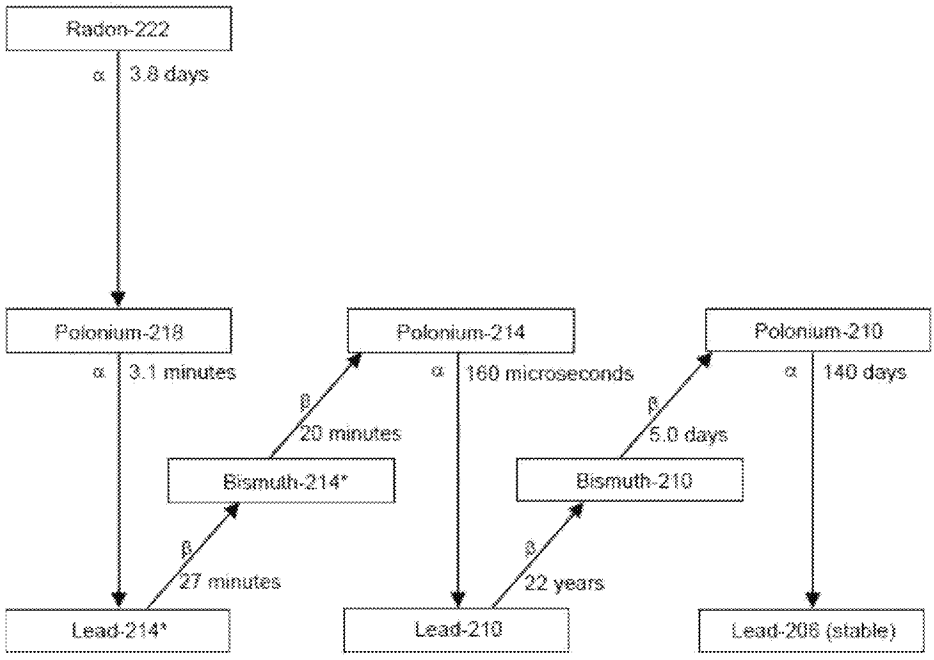
Analytical Method	Analyte	Activity (pCi/g)	Uncertainty (pCi/g)	MDC (pCi/g)	Decay Mode
Gamma Spectroscopy	Be-7	2.821	1.048	1.010	β
	K-40	2.248	1.063	1.770	β
	Co-60	---	0.209	0.147	β
	Cs-137	0.947	0.190	0.158	β
	Eu-152	---	0.170	0.282	β
	Eu-154	---	0.095	0.159	β
	Tl-208	---	0.146	0.180	β
	Pb-210	9.876	1.985	2.020	β
	Bi-212	---	1.880	2.180	α/β
	Pb-212	---	0.132	0.203	β
	Bi-214	---	2.089	1.120	β
	Pb-214	0.328	0.192	0.324	β
	Ra-226	---	1.372	2.290	α
	Ra-228	---	0.325	0.588	β
	Pa-234	---	2.604	1.360	β
	Th-234	---	0.000	2.500	β
	U-235	---	0.433	0.592	α
	U-238	---	0.000	1.860	α
	Am-241	---	0.110	0.184	α
Gross Alpha/Beta	Gross Alpha	24.684	6.848	4.233	α
	Gross Beta	24.345	5.913	1.855	β
Isotopic Pu	Pu-238	---	0.101	0.219	α
	Pu-239/240	---	0.159	0.295	α
Po-210	Po-210	19.743	1.725	0.044	α
Sr-90	Sr-90	0.519	0.342	0.241	β

Neither Ra-226 nor Pu-239 was detected as present in the sample. Therefore, a conclusion can be made that the elevated alpha surface activity is not due to contamination by alpha-emitting radionuclides of concern. The only alpha-emitting radionuclide detected above the sample MDC was Po-210, whose activity accounts for 80% of the reported gross alpha activity (i.e., 19.743 pCi/g ÷ 24.684 pCi/g = 0.800).

Figure 2 shows the natural decay series for radon. Radon decay products are various radioisotopes of Po, Pb, and Bi. Of these radioisotopes, those with the longest half-lives are Pb-210 (22 years) and Po-210 (140 days). The rest have half-lives less than 30 minutes and therefore disappear rapidly when removed from the radon feeder source. As radon decays, its electrically charged progeny attach themselves to dust particles, which deposit onto horizontal surfaces, such as the top of pier components. If the presence of Po-210 was solely due to this deposition mechanism, then sample results would have shown the several Po, Pb, and Bi radioisotopes to be present in similar concentrations in some form of secular equilibrium. But this is not the case. Po-210 parent radionuclides are not present in similar concentrations. So then,

the presence of Po-210 at concentrations much higher than is parent radionuclides is consistent with plate-out of Po-210 on outdoor metal structures as has been confirmed at other sites.

Figure 2 – Radon Decay Series



Conclusion

The presence of Po-210 is not unexpected due to radon decay in the environment and its long half-life (140 days) relative to other radon progeny. The plate-out of Po-210 on outdoor metal structures is a recognized phenomenon that is readily observable primarily on galvanized metal surfaces or metal that is rusty, oxidized, or weathered. As analytical results indicate, Po-210 is clearly the dominant alpha-emitter present in the scraping sample collected from a series of bollards in Ship Berth 14. Po-210 activity composes 80% of the measured gross alpha activity in the sample.

Therefore, once this technical memorandum is approved for use by the Navy, total alpha surface activity measurements of weathered outdoor metal surfaces, such as pier components at HPNS, will be multiplied by a correction factor of 0.2 to remove the alpha activity contribution from the plate-out of Po-210.

Other than Po-210, the several radionuclides listed in Table 3 with reported activity are naturally occurring beta-emitters. A case could be made for a correction factor for beta activity. However, Gilbane has not encountered problems with elevated beta activity above the release criterion and does not believe there is a need for a beta correction factor at this time.

Attachments

HPNS Radiological Survey No. 07204.0004-1107-SBCH, dated 06 Aug 2014, ITSI Gilbane (13 pages).

Laboratory Analysis Report ARS1-14-01921, ARS International, LLC, Port Allen, Louisiana (9 pages).

Gilbane

RADIOLOGICAL SURVEY FORM

CONTRACT NO / TO NO: N62473-10-D-0808	PROJECT TITLE / LOCATION: Rad Remediation D-1, Phase II / HPNS	ITSI GILBANE PROJECT NO: 07204.0004

Survey No.: 07204.0004-1107-SBCH	Date: 8/6/2014	Location: SB 14	Survey Type: SBCH
Danny Bulilan		Ed Palser	
Tech Printed Name	Signature	RSO Printed Name	Signature

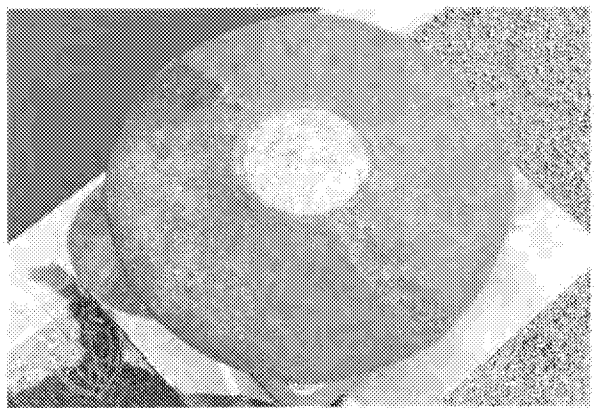
Instrument(s)

Model	Serial	Cal Due Date	Probe Model	Probe Serial	Cal Due Date	BKG α	BKG β	BKG γ	BKG µr/Hr	Eff. α	Eff. β
2360	278618	8/29/2014	43-93	PR311163	8/29/2014	0.2	137.1	N/A	N/A	0.08	0.11

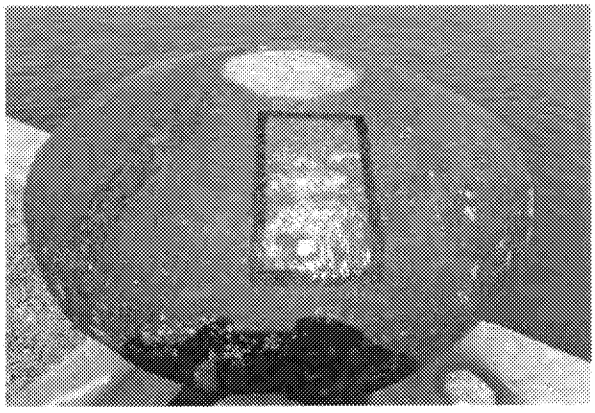
Ship Berth 14

7/22/2014	1	Bollard # 1 Before
	2	Bollard # 1 After
	3	Bollard # 2 Before
	4	Bollard # 2 After
	5	Bollard # 3 Before
	6	Bollard # 3 After
	7	Bollard # 4 Before
	8	Bollard # 4 After

EXAMPLE - Bollard Prior to Sanding



EXAMPLE - Bollard After Sanding



Comments: See Attached Page for Removable Results.

2360 BKGD taken from instrument set up sheet (2 minute).

Direct static readings were collected at each sample location before the sample media was removed and immediately after. No swipes were taken, see volumetric annalytical data for details.

Gilbane	RADIOLOGICAL SURVEY FORM		
CONTRACT NO / TO NO: N62473-10-D-0808	PROJECT TITLE / LOCATION: Rad Remediation D-1, Phase II / HPNS		ITSI GILBANE PROJECT NO: 07204.0004
Survey No.: 07204.0004-1107-SBCH	Date: 8/6/2014	Location: SB 14	Survey Type: SBCH

#	Gross β/γ	Net β/γ (dpm/100 cm^2)	Gross α	Net α (dpm/100 cm^2)	μR/Hr	Location
0001	354	352	34	218	7	# 1 Before
0002	254	-89	4	23	7	# 1 After
0003	298	105	39	251	7	# 2 Before
0004	219	-243	3	17	7	# 2 After
0005	349	330	41	264	7	# 3 Before
0006	229	-199	3	17	7	# 3 After
0007	378	457	54	348	7	# 4 Before
0008	204	-309	4	23	7	# 4 After
N/A	N/A	N/A	N/A	N/A	N/A	N/A

Comments: Gross Static Results Are 2 Min. Counts.

Release Limits: Removable **α 20 dpm/100cm2** **β 200 dpm/100cm2**

Total **α 100 dpm/100cm2** **β 1000 dpm/100cm2**

Technician Name Print: Danny Bulilan

Technician Name Signature: Date: 8/6/2014

Reviewed by: Date: 8/6/2014 Page 2 of 2

SCALER INSTRUMENT SET-UP WORKSHEET

Contract Number / Task Order Number:	Project Title / Location:	ITSI Gilbane Project Number:
N62473-10-D-0808 / 0004	Parcel D1 Phase II / Hunters Point Naval Shipyard	7204.0004

Source Response: **Beta**

(Blue cells for input)

Instrument / SN: 2360/278618 **Cal. Due:** 29-Aug-14
Probe Type / SN: 43-93/PR311163 **Cal. Due:** 29-Aug-14
Technician: C. Bryson
Location: HPNS

Setup Date: 08-Jul-14
Source Cert. Date: 15-Sep-13
Source SN: K7-321
Surface Emission Rate: 27,870 particles/min
Source Type: Tc-99
HV Check/Setting: 800

Background Count Time: 2 minutes
Source/Sample Count Time: 2 minutes

1. Total Background Counts observed:

Chi-squared Calculations

1	249	-25.2	632.5
2	291	16.9	283.9
3	246	-28.2	792.4
4	268	-6.1	37.8
5	278	3.9	14.8
6	317	42.9	1836.1
7	282	7.9	61.6
8	272	-2.1	4.6
9	298	23.9	568.8
10	262	-12.2	147.6
11	279	4.9	23.5
12	232	-42.2	1776.6
13	251	-23.2	535.9
14	284	9.9	97.0
15	233	-41.2	1693.3
16	296	21.9	477.4
17	308	33.9	1145.8
18	248	-26.2	683.8
19	312	37.9	1432.6
20	277	2.9	8.1
		0	

Average Counts = 274.2 counts
Average Count Rate = 137.1 cpm
Standard Deviation = 25.4 counts
Sum of Squares = 12,255
Area Correction Factor (ACF) = 1.00 $100cm^2$
Scan Observation Interval = 1.00 sec

2. Total Source Counts observed:

Chi-squared Calculations

1	12,700	-224	50,086
2	12,894	-30	888
3	12,801	-123	15,080
4	12,803	-121	14,593
5	12,831	-93	8,612
6	13,210	286	81,910
7	13,204	280	78,512
8	12,833	-91	8,245
9	12,895	-29	829
10	12,944	20	408
11	13,057	133	17,742
12	12,863	-61	3,697
13	12,941	17	296
14	12,873	-51	2,581
15	12,896	-28	773
16	12,974	50	2,520
17	13,002	78	6,115
18	12,923	-1	1
19	12,894	-30	888
20	12,936	14	202
		0	

Average Counts = 12,924 counts
Average Count Rate = 6,462 cpm
Standard Deviation = 124 counts
Sum of the Squares = 293,977
Chi-Squared Statistic = 22.75

Acceptable Ranges for Chi-x^2
8.91 to 32.85
(assumes n-1 degrees of freedom; two-tailed distribution @ 95% confidence level)

Net source cts = 12,650 counts
Std. Dev. Net = 127 counts
Net Ct. Rate = 6,325 cpm

Instrument Efficiency (E_i) = 0.2269 cpm/dpm
Surface Efficiency (E_s) = 0.5000 cpm/dpm
Total Efficiency (E_T) = 0.1135 cpm/dpm

MDCR = 125 cpm (@ 95% confidence level)

MDA Scan= **1,559.79** **dpm/100 cm^2**
MDA Static= **493.29** **dpm/100 cm^2**

Bkg count range 223 to 325 (2 sigma)
Source count range 12,675 to 13,173 (2 sigma)

Technical Reviewer

7-8-14
Date

Gilbane

SCALER INSTRUMENT SET-UP WORKSHEET

Contract Number / Task Order Number:	Project Title / Location:	ITSI Gilbane Project Number:
N62473-10-D-0808 / 0004	Parcel D1 Phase II / Hunters Point Naval Shipyard	7204.0004

Source Activity Correction Worksheet

Isotope	Tc-99		
ID #	K7-321		
Initial Activity (dpm)	27,870	Equation:	$Act_r = Act_o \times e^{-((.693/t)T)}$
Ref. Date	15-Sep-13		
Half-life (years)	2.13E+05	7.77E+07 days (Half-life)	
Current Date	8-Jul-14	296.00 days (t)	

Corrected Surface Emission Rate =

27,870 ***particles/min***

Equations

Chi-squared Calculations $\chi^2=\Sigma(o-n)^2$

s_i = 2.09 counts

s_i = minimum detectable number of net source counts in scan observation interval *i*

i = scan observation interval (sec)

Minimum Detectable Count Rate (MDCR) $MDCR = s_i \times 60/i$

$s_i = d' \times SQRT(b_i)$

d' = 1.38 (source: MARSSIM Table 6.5, pg. 6-40; assumes correct decision rate of 95%)

b_i = number of background counts in scan observation interval *i*

Scan Minimum Detectable Concentration (Scan MDC) Scan MDC = MDCR/(SQRT(p) x E_T x ACF)

p = surveyor efficiency (source: MARSSIM Section 6.7.2.1, pg. 6-42)

Static MDC

$$MDC = \frac{3 + 3.29(R_b t_s [1 + t_s/t_b])^{1/2}}{(t_s)(E)(A)}$$

R_b = number of background counts over background count time interval t_b

t_s = sample count time interval (min)

t_b = background count time interval (min)

E = total (instrument + surface) efficiency (cpm/dpm)

A = area correction factor (i.e., detector active area divided by 100) (cm^2)

Review:

7-8-14

Technical Reviewer Date

Gilbane

SCALER INSTRUMENT SET-UP WORKSHEET

Contract Number / Task Order Number:	Project Title / Location:	ITSI Gilbane Project Number:
N62473-10-D-0808 / 0004	Parcel D1 Phase II / Hunters Point Naval Shipyard	7204.0004

Source Response: Alpha

(Blue cells for input)

Instrument / SN: 2360/278618 **Cal. Due:** 29-Aug-14
Probe Type / SN: 43-93/PR311163 **Cal. Due:** 29-Aug-14
Technician: C. Bryson
Location: HPNS

Setup Date: 08-Jul-14
Source Cert. Date: 15-Sep-13
Source SN: K7-323
Surface Emission Rate: 23,650 particles/min
Source Type: Th-230
HV Check/Setting: 800

1. Total Background Counts observed:

Chi-squared Calculations

1	0	-0.4	0.1
2	0	-0.4	0.1
3	0	-0.4	0.1
4	2	1.7	2.7
5	0	-0.4	0.1
6	0	-0.4	0.1
7	0	-0.4	0.1
8	0	-0.4	0.1
9	1	0.7	0.4
10	0	-0.4	0.1
11	0	-0.4	0.1
12	0	-0.4	0.1
13	0	-0.4	0.1
14	0	-0.4	0.1
15	0	-0.4	0.1
16	0	-0.4	0.1
17	1	0.7	0.4
18	0	-0.4	0.1
19	2	1.7	2.7
20	1	0.7	0.4
		0	

Background Count Time: 2 minutes
Source/Sample Count Time: 2 minutes

Average Counts = 0.4 counts
Average Count Rate = 0.2 cpm
Standard Deviation = 0.7 counts
Sum of Squares = 9
Area Correction Factor (ACF) = 1.00 $100cm^2$
Scan Observation Interval = 1.00 sec

2. Total Source Counts observed:

Chi-squared Calculations

1	14,498	-79	6,225
2	14,546	-31	955
3	14,466	-111	12,299
4	14,442	-135	18,198
5	14,703	126	15,901
6	14,534	-43	1,840
7	14,459	-118	13,900
8	14,485	-92	8,446
9	14,662	85	7,242
10	14,579	2	4
11	14,816	239	57,169
12	14,911	334	111,623
13	14,327	-250	62,450
14	14,458	-119	14,137
15	14,566	-11	119
16	14,857	280	78,456
17	14,637	60	3,612
18	14,588	11	123
19	14,403	-174	30,241
20	14,601	24	581
		0	

Average Counts = 14,577 counts
Average Count Rate = 7,288 cpm
Standard Deviation = 153 counts
Sum of the Squares = 443,522
Chi-Squared Statistic = 30.43

Acceptable Ranges for Chi-x^2
8.91 to 32.85
(assumes n-1 degrees of freedom; two-tailed distribution @ 95% confidence level)

Net source cts = 14,577 counts
Std. Dev. Net = 153 counts
Net Ct. Rate = 7,288 cpm

Instrument Efficiency (E_i) = 0.3082 cpm/dpm
Surface Efficiency (E_s) = 0.2500 cpm/dpm
Total Efficiency (E_T) = 0.0770 cpm/dpm

MDCR = N/A cpm (@ 95% confidence level)

MDA Scan= **N/A** **dpm/100 cm^2**
MDA Static= **44.73** **dpm/100 cm^2**

Bkg count range 0 to 2 (2 sigma)
Source count range 14,271 to 14,882 (2 sigma)

Technical Reviewer

7-8-14
Date

Contract Number / Task Order Number:	Project Title / Location:	ITSI Gilbane Project Number:
N62473-10-D-0808 / 0004	Parcel D1 Phase II / Hunters Point Naval Shipyard	7204.0004

Source Activity Correction Worksheet

Isotope	Th-230		
ID #	K7-323		
Initial Activity (dpm)	23,650	Equation:	$Act_t = Act_o \times e^{-((.693/t)T)}$
Ref. Date	15-Sep-13		
Half-life (years)	7.54E+04	2.75E+07 days (Half-life)	
Current Date	8-Jul-14	296.00 days (t)	

Corrected Surface Emission Rate =

23,650 ***particles/min***

Equations

Chi-squared Calculations $\chi 2=\Sigma(n-n)^2$

s_i = 0.07 counts

s_i = minimum detectable number of net source counts in scan observation interval *i*
i = scan observation interval (sec)

Minimum Detectable Count Rate (MDCR) $MDCR = s_i \times 60/i$

$s_i = d' \times SQRT(b_i)$

d' = 1.38 (source: MARSSIM Table 6.5, pg. 6-40; assumes correct decision rate of 95%)
b_i = number of background counts in scan observation interval *i*

Scan Minimum Detectable Concentration (Scan MDC) $Scan\ MDC = MDCR/(SQRT(p) \times E_T \times ACF)$

p = surveyor efficiency (source: MARSSIM Section 6.7.2.1, pg. 6-42)

Static MDC

$$MDC = \frac{3 + 3.29(R_b t_s (1 + t_s/t_b))^{1/2}}{(t_s)(E)(A)}$$

R_b = number of background counts over background count time interval t_b
t_s = sample count time interval (min)
t_b = background count time interval (min)
E = total (instrument + surface) efficiency (cpm/dpm)
A = area correction factor (i.e., detector active area divided by 100) (cm^2)

Review:

7-6-14

Technical Reviewer Date

Designer and Manufacturer of Scientific and Industrial Instruments

CERTIFICATE OF CALIBRATION

LUDLUM MEASUREMENTS, INC.

501 Oak Street, Sweetwater, TX 79556, U.S.A., 325-235-5494

10744 Dutchtown Road, Knoxville, TN 37932 U.S.A., 865-392-4801

CUSTOMER: ENVIRACHEM, INC

ORDER NO.: 20220136/396027

Mfg:	Ludlum Measurements, Inc.	Model:	2360	Serial No:	278615
Mfg:	Ludlum Measurements, Inc.	Model:	43-93	Serial No:	PR311163

Cal. Date: 29-Aug-13 Cal Due Date: 29-Aug-14 Cal. Interval: 1 Year Meterface: 202-855

Check mark: ✓ applies to applicable instr. and/or detector IAW mfg. spec. T: 73 °F RH: 36 % Alt: 701.8 mm Hg

New Instrument; Instrument Received; ~ Within Toler. +-10%; 10-20%; Out of Tol; Requiring Repair; Other-See comments

✓ Mechanical ck.	✓ Meter Zeroed	Background Subtract	Input Sens. Linearity
F/S Resp. ck.	✓ Reset ck.	✓ Window Operation	✓ Geotropism
✓ Audio ck.	✓ Alarm Setting ck.	✓ Batt. ck. (Min. Volt) 2.2 VDC	~ RS-232 Port OK

~ Calibrated in accordance with LMI SOP 14.8 rev 12/05/89 Calibrated in accordance with LMI SOP 14.9 rev 02/07/97

Instrument Volt Set: 800 V

✓ HV Readout (2 points): Ref./Inst: 500 / 501 V Ref./Inst: 2000 / 2001 V

Firmware Version: 3901v24

Alpha Threshold: 120 mv

Beta Threshold: 3.5 mv

Beta Window: 30 mv

Overload: Set to Simulate light leak.

Instrument calibrated with a 36" cable

High voltage set with detector: not connected.

(EEPROM Settings)

User Time: 0.1

Alpha Alarm: 999999

Beta Alarm: 999999

A/B Alarm: 999999

Model 2360 Date: 8/29/2013

Calibration Date Due: 8/29/2014

COMMENTS:

Gamma Calibration: GM detectors positioned perpendicular to source except for M 44-9 in which the front of probe faces source

RANGE/MULTIPLIER	REFERENCE CAL. POINT	INSTRUMENT REC'D "AS FOUND READING"	INSTRUMENT METER READING*
x1000	400k cpm	405	400
x1000	100k cpm	101	100
x100	40k cpm	405	400
x100	10k cpm	101	100
x10	4k cpm	405	400
x10	1k cpm	101	100
x1	400 cpm	405	400
x1	100 cpm	101	102

*Uncertainty within ± 10% C.F. within ± 20% ALL Range(s) Calibrated Electronically

	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*		REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
Digital Readout	400kcpm	40034 (0)	40034 (0)	Log Scale			
	40kcpm	4003	4003				
	4kcpm	400	400				
	400cpm	40	40				
	40cpm	4	4				

Ludlum Measurements, Inc. certifies that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology, or to the calibration facilities of other International Standards Organization members, or have been derived from accepted values of natural physical constants or have been derived by the ratio type of calibration technique. The calibration system conforms to the requirements of ANSI/NCSL Z540-1-1994 and ANSI N323-1978. State of Texas Calibration License No: LO-1963

Reference Instruments and/or Sources: 069 280 720 724 781 1131 1616 1696 6105 9717CO 9719CO 60648 70897 73410 E581 E582 G112 M665 S-394 S-1054 T-304 T679 T10081 T10082 Y982

✓ Alpha S/N: Pu239 SN:7053 ✓ Beta S/N: Tc99SN:5280 SrY90SN:5281 Other:

✓ m 500 S/N: 190566 Oscilloscope S/N: ✓ Multimeter S/N: 86250390

Calibrated By: Date: 29-Aug-13

Reviewed By: Date: 29Aug13

AC Inst. Only: Passed Dielectric (Hi-Pot) and Continuity Test Failed

Designer and Manufacturer
of
Scientific and Industrial
Instruments

LUDLUM MEASUREMENTS, INC.
501 Oak Street
325-235-5494
Sweetwater, TX 79556, U.S.A.

10744 Dutchtown Road
865-392-4501
Knoxville, TN 37932, U.S.A.

Bench Test Data For Detector

Detector 43-93 Serial No. PR 311163 Order # 20229136/396037

Customer ENVIRACHEM, INC

Counter 2360 Serial No 278618

Count Time 1Minute

Other

Alpha Input Sensitivity 120 mV

Beta Input Sensitivity 3.5 mV

Beta Window 30 mV

Distance Source to Detector Surface

High Voltage	Background		Isotope Ra 239 Size 24900dpm		Isotope Tc 99 Size 93200dpm		Isotope SrY90 Size 97293dpm	
	Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta
750	2	131	4669	354	26	11316	3	20485
775	2	178	5170	332	32	14732	2	25823
800	1	237	5521	430	16	18093	4	30774
825	1	276	5570	505	23	20973	4	33633
850	2	295	5667	569	27	23433	4	33845

Gas Proportional detector count rate decreased ≤ 10% after 15 hour static test using 36" cable.

Gas proportional detector count rate decreased ≤ 10% after 5 hour static test using 36" cable and alpha/beta counter.

Signature

Date 29-Aug-13

Header 1: John Q. Public
Header 2: SN: 275616
Header 3: SN: PR311163
Header 4: Site: Bldg 1
Header 5: RM 008, S. Wall
Header 6: Comment
Location:

Calibration Due Date: 08/29/2014
Model 2360 Date: 08/29/2013
Model 2360 Time: 10:40:33 AM

Logged Samples: 0

User PC Scaler Count Time: 0.1 minutes

Alpha Ratemeter Alarm Setpoint:	999999
Beta Ratemeter Alarm Setpoint:	999999
Alpha + Beta Ratemeter Alarm Setpoint:	999999
Alpha Scaler Alarm Setpoint:	999999
Beta Scaler Alarm Setpoint:	999999
Alpha + Beta Scaler Alarm Setpoint:	999999

Eckert & Ziegler
Isotope Products

24937 Avenue Tibbitts
Valencia, California 91355

Tel 661·309·1010
Fax 661·257·8303

CERTIFICATE OF CALIBRATION
BETA STANDARD SOURCE

Radionuclide:	Tc-99	**Customer:**	RES, LLC
Half-life:	(2.13 ± 0.05)E+05 years	**P.O. No.:**	10557 EZIP
Catalog No.:	EAB-099-47LB	**Reference Date:**	15-Sep-13 12:00 PST
Source No.:	K7-321	**Contained Radioactivity:**	22.83 nCi 844.7 Bq

Physical Description:

A.	Capsule type:	Disk (47 mm OD x 0.76 mm THK)
B.	Nature of active deposit:	Electrodeposited and diffusion bonded Technetium metal
C.	Active diameter/volume:	41 mm
D.	Backing:	Stainless steel
E.	Cover:	None

CAUTION!
DELICATE SURFACE
DO NOT WIPE
ACTIVE AREA

Radioimpurities:

None detected

Method of Calibration:

This source was assayed using a windowless internal gas flow proportional counter.

Uncertainty of Measurement:

A.	Type A (random) uncertainty:	± 0.4 %
B.	Type B (systematic) uncertainty:	± 3.0 %
C.	Uncertainty in aliquot weighing:	± 0.0 %
D.	Total uncertainty at the 99% confidence level:	± 3.0 %

Notes:

- See reverse side for leak test(s) performed on this source.
- EZIP participates in a NIST measurement assurance program to establish and maintain implicit traceability for a number of nuclides, based on the blind assay (and later NIST certification) of Standard Reference Materials (as in NRC Regulatory Guide 4.15).
- Nuclear data was taken from "Table of Radioactive Isotopes", edited by Virginia Shirley, 1986.
- This source has a working life of 2 years.
- This source had a surface emission rate of 27870 β/min in 2π on 28-Aug-13.

Daniel Jaworski Van Dalsem
Quality Control

29-Aug-13
Date

EZIP Ref. No.: 1684-91

THE LEAK TEST(S) INDICATED BY THE CHECKED BOX(ES) WAS(WERE) APPLIED TO DETERMINE THE INTEGRITY OF THE SOURCE DESCRIBED ON THE FRONT SIDE. THE LEAK TESTS INDICATED BELOW WERE EITHER TAKEN DIRECTLY FROM ISO 9978:1992 OR DERIVED FROM THE LEAK TEST METHODS LISTED IN ISO 9978:1992. THE REGULATORY LIMIT FOR LEAK TEST RESULTS IS <5 nCi (185 Bq) FOR BOTH ALPHA AND BETA-GAMMA ACTIVITY. LEAK TEST RESULTS MARKED BELOW CONTAINED <5 nCi (185 Bq) OF REMOVABLE ACTIVITY UNLESS OTHERWISE STATED ON THIS CERTIFICATE.

☐ **Standard Wipe Test**

The source was wiped over its entire surface with a moistened filter paper disk. After drying, the disk was checked for activity using a scintillation detector.

☐ **Special Wipe Test**

The source was wiped over its entire surface with moistened polystyrene. The polystyrene was then dissolved in a liquid scintillation cocktail and counted in a liquid scintillation counter.

☐ **Distilled Water Soak Test**

The source was immersed in distilled water and maintained at (50 ± 5)°C for a minimum of four hours or room temperature (20 ± 5)°C for 24 hours. After removal of the source, the liquid was a) checked for activity using a liquid scintillation counter, or b) evaporated in a planchet and the residue checked for activity using a windowless proportional counter or end-window G.M. tube.

☐ **Liquid Scintillation Soak Test**

The source was immersed for a minimum of 3 hours at room temperature(20 ± 5)°C in a liquid scintillation cocktail, which does not attack the source's outer surface material. The source was stored away from light to avoid photoluminescence. The sealed source was then removed and the activity of the liquid scintillation cocktail was measured.

☐ **Gas Source Test**

The source was placed in a vacuum desiccator and maintained at a pressure of <10 mm Hg for not less than 12 hours. The activity was checked by introducing air into the desiccator and monitoring the air with an end-window G.M. tube.

☐ **Ampoule Leak Test**

The ampoule was kept in an inverted position on a filter paper disk or polystyrene wipe for a minimum of 16 hours. The wipe was then checked for activity using a scintillation detector or liquid scintillation counter.

☐ **Bubble Leak Test**

The container was pressurized to its fill pressure; then soapy water was applied over its valve and neck or, the valve and neck of the vessel were immersed in water. If no growing bubbles were observed, the container was considered leak free.

☐ **Wipe Test for Industrial Ni-63 Sources**

The sources were wipe tested by an approved sampling plan, which called for either 100% of the batch to be individually wipe tested, or, a subset thereof. The wipe test(s) used to test for removable contamination and the results of those tests are recorded on the front of this form.

☐ **Pressure Test for Triotech Kr-85 Sources**

Prior to filling the vessel with Kr-85 gas, the vessel was evacuated to <5 mm Hg, the gas manifold system shut off and the system allowed to stand for a minimum of 30 minutes. A vacuum difference not greater than the known vacuum loss of the manifold system itself signified the vessel did not leak.

☑ **Leak Test Not Applicable**

The active area of the source is uncovered or is protected by a very thin coating. Although the deposit is adherent, it is not designed or certified to pass a standard leak test. The inactive portions of the source have been checked using the standard wipe test or special wipe test depending on the nuclide.

☐ **Other Leak Test**

Eckert & Ziegler
Isotope Products

24937 Avenue Tibbitts
Valencia, California 91355

Tel 661•309•1010
Fax 661•257•8303

CERTIFICATE OF CALIBRATION
ALPHA STANDARD SOURCE

Radionuclide:	Th-230	**Customer:**	RES, LLC
Half-life:	(7.54 ± 0.03)E+04 years	**P.O. No.:**	10557 EZIP
Catalog No.:	EAB-230-47LB	**Reference Date:**	15-Sep-13 12:00 PST
Source No.:	K7-323	**Contained Radioactivity:**	21.09 nCi 780.3 Bq

Physical Description:

CAUTION!
DELICATE SURFACE
DO NOT WIPE
ACTIVE AREA

A.	Capsule type:	Disk (47 mm OD x 0.76 mm THK)
B.	Nature of active deposit:	Electrodeposited and diffusion bonded oxide
C.	Active diameter/volume:	41 mm
D.	Backing:	Stainless steel
E.	Cover:	None

Radioimpurities:

None detected

Method of Calibration:

This source was assayed using a windowless internal gas flow proportional counter.

Uncertainty of Measurement:

A.	Type A (random) uncertainty:	± 0.4 %
B.	Type B (systematic) uncertainty:	± 3.0 %
C.	Uncertainty in aliquot weighing:	± 0.0 %
D.	Total uncertainty at the 99% confidence level:	± 3.0 %

Notes:

- See reverse side for leak test(s) performed on this source.
- EZIP participates in a NIST measurement assurance program to establish and maintain implicit traceability for a number of nuclides, based on the blind assay (and later NIST certification) of Standard Reference Materials (as in NRC Regulatory Guide 4.15).
- Nuclear data was taken from "Table of Radioactive Isotopes", edited by Virginia Shirley, 1986.
- This source has a working life of 2 years.
- This source had a surface emission rate of 23650 α/min in 2π on 28-Aug-13.

Daniel James Van Dalsem
Quality Control

29-Aug-13
Date

EZIP Ref. No.: 1684-91

THE LEAK TEST(S) INDICATED BY THE CHECKED BOX(ES) WAS(WERE) APPLIED TO DETERMINE THE INTEGRITY OF THE SOURCE DESCRIBED ON THE FRONT SIDE. THE LEAK TESTS INDICATED BELOW WERE EITHER TAKEN DIRECTLY FROM ISO 9978:1992 OR DERIVED FROM THE LEAK TEST METHODS LISTED IN ISO 9978:1992. THE REGULATORY LIMIT FOR LEAK TEST RESULTS IS <5 nCi (185 Bq) FOR BOTH ALPHA AND BETA-GAMMA ACTIVITY. LEAK TEST RESULTS MARKED BELOW CONTAINED <5 nCi (185 Bq) OF REMOVABLE ACTIVITY UNLESS OTHERWISE STATED ON THIS CERTIFICATE.

☐ **Standard Wipe Test**

The source was wiped over its entire surface with a moistened filter paper disk. After drying, the disk was checked for activity using a scintillation detector.

☐ **Special Wipe Test**

The source was wiped over its entire surface with moistened polystyrene. The polystyrene was then dissolved in a liquid scintillation cocktail and counted in a liquid scintillation counter.

☐ **Distilled Water Soak Test**

The source was immersed in distilled water and maintained at (50 ± 5)°C for a minimum of four hours or room temperature (20 ± 5)°C for 24 hours. After removal of the source, the liquid was a) checked for activity using a liquid scintillation counter, or b) evaporated in a planchet and the residue checked for activity using a windowless proportional counter or end-window G.M. tube.

☐ **Liquid Scintillation Soak Test**

The source was immersed for a minimum of 3 hours at room temperature(20 ± 5)°C in a liquid scintillation cocktail, which does not attack the source's outer surface material. The source was stored away from light to avoid photoluminescence. The sealed source was then removed and the activity of the liquid scintillation cocktail was measured.

☐ **Gas Source Test**

The source was placed in a vacuum desiccator and maintained at a pressure of <10 mm Hg for not less than 12 hours. The activity was checked by introducing air into the desiccator and monitoring the air with an end-window G.M. tube.

☐ **Ampoule Leak Test**

The ampoule was kept in an inverted position on a filter paper disk or polystyrene wipe for a minimum of 16 hours. The wipe was then checked for activity using a scintillation detector or liquid scintillation counter.

☐ **Bubble Leak Test**

The container was pressurized to its fill pressure; then soapy water was applied over its valve and neck or, the valve and neck of the vessel were immersed in water. If no growing bubbles were observed, the container was considered leak free.

☐ **Wipe Test for Industrial Ni-63 Sources**

The sources were wipe tested by an approved sampling plan, which called for either 100% of the batch to be individually wipe tested, or, a subset thereof. The wipe test(s) used to test for removable contamination and the results of those tests are recorded on the front of this form.

☐ **Pressure Test for Triotech Kr-85 Sources**

Prior to filling the vessel with Kr-85 gas, the vessel was evacuated to <5 mm Hg, the gas manifold system shut off and the system allowed to stand for a minimum of 30 minutes. A vacuum difference not greater than the known vacuum loss of the manifold system itself signified the vessel did not leak.

☑ **Leak Test Not Applicable**

The active area of the source is uncovered or is protected by a very thin coating. Although the deposit is adherent, it is not designed or certified to pass a standard leak test. The inactive portions of the source have been checked using the standard wipe test or special wipe test depending on the nuclide.

☐ **Other Leak Test**

2609 North River Road, Port Allen, Louisiana 70767
(800) 401-4277 -- FAX (225) 381-2996

ARS INTERNATIONAL

ARS International, LLC

Laboratory Analysis Report

ARS1-14-01921

Prepared for:

ITSI Gilbane

Ed Palser
2730 Shadelands Drive
Walnut Creek, CA 94598

epalser@gilbaneco.com

Phone: (505) 400-4076

Project Manager Review

Management Review

Notes: ARS International, LLC assumes no liability for the use or interpretation of any analytical results provided other than the cost of the analysis itself. Reproduction of this report in less than full requires the written consent of the client.

Contact Person: Questions regarding this analytical report should be addressed to:

Project Manager

ProjectManagers@amrad.com

Phone: 225.381.2991
Fax: 225.381.2996

LELAP Cert# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

ARS Sample Delivery Group: ARS1-14-01921
Client Sample ID: 04SBD-14 (B1-B4)-001
Sample Collection Date: 07/22/14
Sample Matrix: Soil/Solid/Sludge

Request or PO Number: N/A
ARS Sample ID: ARS1-14-01921-001
Date Received: 07/24/14
Report Date: 08/15/14

Analysis Description	Analysis Results	CSU +/- 2 s	MDC	DLC	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Tracer/Chem Recovery
K-40	2.248	1.063	1.770	0.885		pCi/g	ARS-007/EPA 901.1M	07/24/14 16:05	JDT	N/A
CO-60	-0.020	0.209	0.147	0.074	U	pCi/g	ARS-007/EPA 901.1M	07/24/14 16:05	JDT	N/A
BE-7	2.821	1.048	1.010	0.505		pCi/g	ARS-007/EPA 901.1M	07/24/14 16:05	JDT	N/A
CS-137	0.947	0.190	0.158	0.079		pCi/g	ARS-007/EPA 901.1M	07/24/14 16:05	JDT	N/A
EU-152	0.040	0.170	0.282	0.141	U	pCi/g	ARS-007/EPA 901.1M	07/24/14 16:05	JDT	N/A
EU-154	0.000	0.095	0.159	0.080	U	pCi/g	ARS-007/EPA 901.1M	07/24/14 16:05	JDT	N/A
TL-208	-0.057	0.146	0.180	0.090	U	pCi/g	ARS-007/EPA 901.1M	07/24/14 16:05	JDT	N/A
PB-210	9.876	1.985	2.020	1.010		pCi/g	ARS-007/EPA 901.1M	07/24/14 16:05	JDT	N/A
BI-212	-0.228	1.880	2.180	1.090	U	pCi/g	ARS-007/EPA 901.1M	07/24/14 16:05	JDT	N/A
PB-212	0.087	0.132	0.203	0.102	U	pCi/g	ARS-007/EPA 901.1M	07/24/14 16:05	JDT	N/A
BI-214	0.251	2.089	1.120	0.571	U	pCi/g	ARS-007/EPA 901.1M	07/24/14 16:05	JDT	N/A
PB-214	0.328	0.192	0.324	0.162		pCi/g	ARS-007/EPA 901.1M	07/24/14 16:05	JDT	N/A
RA-226	0.198	1.372	2.290	1.145	U	pCi/g	ARS-007/EPA 901.1M	07/24/14 16:05	JDT	N/A
RA-228	0.031	0.325	0.588	0.294	U	pCi/g	ARS-007/EPA 901.1M	07/24/14 16:05	JDT	N/A
PA-234	-0.608	2.604	1.360	0.680	U	pCi/g	ARS-007/EPA 901.1M	07/24/14 16:05	JDT	N/A
TH-234	0.000	0.000	2.500	1.250	U	pCi/g	ARS-007/EPA 901.1M	07/24/14 16:05	JDT	N/A
U-235	0.066	0.433	0.592	0.296	U	pCi/g	ARS-007/EPA 901.1M	07/24/14 16:05	JDT	N/A
U-238	0.000	0.000	1.860	0.930	U	pCi/g	ARS-007/EPA 901.1M	07/24/14 16:05	JDT	N/A
AM-241	-0.002	0.110	0.184	0.092	U	pCi/g	ARS-007/EPA 901.1M	07/24/14 16:05	JDT	N/A
GROSS ALPHA	24.684	6.848	4.233	2.005		pCi/g	ARS-003/EPA 900.0M	07/25/14 15:18	CB	N/A
GROSS BETA	24.345	5.913	1.855	0.909		pCi/g	ARS-003/EPA 900.0M	07/25/14 15:18	CB	N/A
PU-238	0.032	0.101	0.219	0.065	U	pCi/g	ARS-026/Eichrom ACW-03	07/29/14 15:38	JB	8%
PU-239/240	0.081	0.159	0.295	0.103	U	pCi/g	ARS-026/Eichrom ACW-03	07/29/14 15:38	JB	8%
PO-210	19.743	1.725	0.044	0.022		pCi/g	ARS-034/HASL-PO-01 RC	07/30/14 16:24	BJS	46%
SR-90	0.519	0.342	0.515	0.241		pCi/g	ARS-032/Eichrom SRW01	08/08/14 16:59	BJS	83%

NOTES:

VLM

Project Manager Review

LELAP Certificate# 01949

2609 North River Road, Port Allen, Louisiana 70767
1 (800) 401-4277 FAX (225) 381-2996

QC Results Report

Sample Delivery Group: ARS1-14-01921
Date Received: 07/24/14

Laboratory Control Sample Evaluation

Analysis Batch	QC Type	Analyte	Analysis Results	CSU 1 (2s)	MDC	Expected Value	Qual	Report Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Percent Recovery (%)	LCS Acceptance Range
ARS1-B14-01743	LCS	Sr-90	20.07	3.14	0.54	19.59		pCi/g	ARS-032/EPA 905.0	8/8/14 16:59	BJS	102	75%-125%

Blank Evaluation

Analysis Batch	QC Type	Analyte	Analysis Results	CSU 1 (2s)	MDC	Expected Value	Qual	Report Units	Analysis Test Method	Analysis Date/Time	Analysis Technician
ARS1-B14-01743	MBL	Sr-90	0.17	0.31	0.52	NA	U	pCi/g	ARS-032/EPA 905.0	8/8/14 16:59	BJS

RER Duplicate Evaluation

Analysis Batch	QC Type	Analysis Description	Result 1	CSU 1 (2s)	Result 2	CSU 2 (2s)	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	RER	RER AcceptanceRange
ARS1-B14-01743	LCSD	Sr-90	20.07	3.14	18.96	2.97		pCi/g	ARS-032/EPA 905.0	8/8/14 16:59	BJS	0.18	< 1

DER Duplicate Evaluation

Analysis Batch	QC Type	Analysis Description	Result 1	CSU 1 (2s)	Result 2	CSU 2 (2s)	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	DER	DER AcceptanceRange
ARS1-B14-01743	LCSD	Sr-90	20.07	3.14	18.96	2.97		pCi/g	ARS-032/EPA 905.0	8/8/14 16:59	BJS	0.51	< 3

Project Manager Review

LELAP Certificate# 30658 NELAP Certificate # E87558

ARS INTERNATIONAL

QC Results per Analytical Batch

Analytical Batch	ARS1-B14-01589
SDG	ARS1-14-01921
Analysis	Gross Alpha/Beta (Soil, Sludge, Waste,
Analysis Test Method	ARS-003/Gas Proportional Counter
Analysis Code	GPC-A-003
Report Units	pCi/g

Acceptable QC Performance Ranges

QC Sample Type	Performance Items and Ranges		
Laboratory Control Sample	Recovery (%):	> 75	< 125
Matrix Spike	Recovery (%):	> 60	< 140
Duplicate	Replicate Error Ratio (RER):		< 1
	Duplicate Error Ratio (DER):		< 3
	Relative Percent Difference (RPD %):		≤ 25

Laboratory Control Sample

Analysis Date: 07/25/14 15:18 / 07/25/14 15:18 — Analysis Technician: AMRAD\CBAILEY / AMRAD\CBAILEY

Analysis Batch Sample ID	QC Type	Analyte	Results	CSU (2s)	Expected Value	LCS Rec (%)	MDC
ARS1-B14-01589-01	LCS	GROSS ALPHA	6.9	1.6	6.3	109	0.18
ARS1-B14-01589-01	LCS	GROSS BETA	49	11	39	125	0.20

Duplicate RER/DER/RPD

Analysis Date: 07/25/14 15:18 / 07/25/14 15:18 — Analysis Technician: AMRAD\CBAILEY / AMRAD\CBAILEY

Analyte	Result LCS	CSU LCS (2s)	Results LCSD	CSU LCSD (2s)	RER	DER	RPD
GROSS ALPHA	6.87	1.63	6.38	1.52	0.16	0.43	7.4
GROSS BETA	49.0	11.5	48.4	11.3	0.03	0.07	1.2

Method Blank

Analysis Date: 07/25/14 15:18 / 07/25/14 15:18 — Analysis Technician: AMRAD\CBAILEY / AMRAD\CBAILEY

Analysis Batch Sample ID	QC Type	Analyte	Results	CSU (2s)	MDC	Qual
ARS1-B14-01589-03	MBL	GROSS ALPHA	-0.018	0.078	0.14	U
ARS1-B14-01589-03	MBL	GROSS BETA	-0.04	0.12	0.20	U

VLM

LELAP Certificate# 01949

QC Results per Analytical Batch

Analytical Batch	ARS1-B14-01598
SDG	ARS1-14-01921
Analysis	Plutonium Solid, Waste, Biota, Sediment,
Analysis Test Method	ARS-026/Eichrom ACW-03-15
Analysis Code	ASP-A-023
Report Units	pCi/g

Acceptable QC Performance Ranges

QC Sample Type	Performance Items and Ranges		
Laboratory Control Sample	Recovery (%):	> 75	< 125
Matrix Spike	Recovery (%):	> 60	< 140
Duplicate	Replicate Error Ratio (RER):		< 1
	Duplicate Error Ratio (DER):		< 3
	Relative Percent Difference (RPD %):		≤ 25

Laboratory Control Sample

Analysis Date: 07/29/14 15:38 | Analysis Technician: JBYRD

Analysis Batch Sample ID	QC Type	Analyte	Results	CSU (2s)	Expected Value	LCS Rec (%)	MDC
ARS1-B14-01598-01	LCS	PU-239/240	5.10	0.71	5.36	95	0.016

Duplicate RER/DER/RPD

Analysis Date: 07/29/14 15:38 | Analysis Technician: JBYRD

Analyte	Result LCS	CSU LCS (2s)	Results LCSD	CSU LCSD (2s)	RER	DER	RPD
PU-239/240	5.10	0.71	4.87	0.68	0.17	0.46	4.6

Method Blank

Analysis Date: 07/29/14 15:38, 07/29/14 15:38 | Analysis Technician: JBYRD, JBYRD

Analysis Batch Sample ID	QC Type	Analyte	Results	CSU (2s)	MDC	Qual
ARS1-B14-01598-03	MBL	PU-238	-0.016	0.016	0.069	U
ARS1-B14-01598-03	MBL	PU-239/240	0.000	0.028	0.069	U

VHM

LELAP Certificate# 01949

ARS INTERNATIONAL

QC Results per Analytical Batch

Analytical Batch	ARS1-B14-01573
SDG	ARS1-14-01921
Analysis	Gamma Spec (Solid)
Analysis Test Method	ARS-007/EPA 901.1M
Analysis Code	GAM-A-020
Report Units	pCi/g

Acceptable QC Performance Ranges

QC Sample Type	Performance Items and Ranges		
Laboratory Control Sample	Recovery (%):	> 75	< 125
Matrix Spike	Recovery (%):	> 60	< 140
Duplicate	Replicate Error Ratio (RER):		< 1
	Duplicate Error Ratio (DER):		< 3
	Relative Percent Difference (RPD %):		≤ 25

Laboratory Control Sample

Analysis Date	07/24/14 13:35	Analysis Technician	BZF		

Analysis Batch Sample ID	QC Type	Analyte	Results	CSU (2s)	Expected Value	LCS Rec (%)	MDC
ARS1-B14-01573-01	LCS	AM-241	48800	3900	40838	119	410
ARS1-B14-01573-01	LCS	CO-60	57500	2300	50514	114	480
ARS1-B14-01573-01	LCS	CS-137	47300	2000	40351	117	210

Duplicate RER/DER/RPD

Analysis Date	07/24/14 14:47	Analysis Technician	BZF		

Analyte	Result LCS	CSU LCS (2s)	Results LCSD	CSU LCSD (2s)	RER	DER	RPD
AM-241	48800	3923	46700	3499	0.28	0.78	4.4
CO-60	57500	2301	53600	2151	0.87	2.40	7.0
CS-137	47300	1981	44320	1826	0.79	2.18	6.5

Method Blank

Analysis Date	07/24/14 16:53	Analysis Technician	JDT		

Analysis Batch Sample ID	QC Type	Analyte	Results	CSU (2s)	MDC	Qual
ARS1-B14-01573-03	MBL	AM-241	0.4	1.1	1.9	U
ARS1-B14-01573-03	MBL	CO-60	0.59	0.94	1.6	U
ARS1-B14-01573-03	MBL	CS-137	-0.3	5.8	1.9	U

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1 (800) 401-4277 FAX (225) 381-2996

QC Results Report

Sample Delivery Group: ARS1-14-01921
Date Received: 07/24/14

Laboratory Control Sample Evaluation

Analysis Batch	QC Type	Analyte	Analysis Results	CSU 1 (2s)	MDC	Expected Value	Qual	Report Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	Percent Recovery (%)	LCS Acceptance Range
ARS1-B14-01600	LCS	PO-210	6.380	0.559	0.014	6.484		pCi/L	ARS-030/Eichrom OTW-01	7/30/14 16:24	BJS	98	75%-125%

Blank Evaluation

Analysis Batch	QC Type	Analyte	Analysis Results	CSU 1 (2s)	MDC	Expected Value	Qual	Report Units	Analysis Test Method	Analysis Date/Time	Analysis Technician
ARS1-B14-01600	MBL	PO-210	0.007	0.002	0.041	NA	U	pCi/L	ARS-030/Eichrom OTW-01	7/30/14 16:24	BJS

RER Duplicate Evaluation

Analysis Batch	QC Type	Analysis Description	Result 1	CSU 1 (2s)	Result 2	CSU 2 (2s)	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	RER	RER AcceptanceRange
ARS1-B14-01600	LCSD	PO-210	6.380	0.559	5.900	0.517		pCi/L	ARS-030/Eichrom OTW-01	7/30/14 16:24	BJS	0.45	< 1

DER Duplicate Evaluation

Analysis Batch	QC Type	Analysis Description	Result 1	CSU 1 (2s)	Result 2	CSU 2 (2s)	Qual	Analysis Units	Analysis Test Method	Analysis Date/Time	Analysis Technician	DER	DER AcceptanceRange
ARS1-B14-01600	LCSD	PO-210	6.380	0.559	5.900	0.517		pCi/L	ARS-030/Eichrom OTW-01	7/30/14 16:24	BJS	1.26	< 3

Project Manager Review

LELAP Certificate# 01949 NELAP Certificate # E87558

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Notes:

Comments:

1.0) Soil and Sludge analysis are reported on a wet basis or an as received basis unless otherwise indicated.
2.0) Data in this report are within the limits of uncertainty specified in the reference method unless otherwise specified.
3.0) Modified analysis procedures are procedures that are modified to meet the certain specifications. An example may be the use of a water method to analyze a solid matrix due to the lack of an officially recognized procedure for the analysis of the solid matrix. Modified analyses are indicated by the subsequent addition of "m" to the procedure number (i.e. 900.0M).
4.0) Derived Air Concentrations and Effluent Release Concentrations are obtained from 10 CFR 20 Appendix B.
5.0) **Total activity** is actually total gamma activity and is determined utilizing the prominent gamma emitters from the naturally occurring radioactive decay chains and other prominent radioactive nuclides. Total activity may be lower than the actual total activity due to the extent of secular equilibrium achieved in the various decay chains at the time of analysis. The total activity is not representative of nuclides that emit solely alpha or beta particles.
6.0) Ra-228 is determined via secular equilibrium with its daughter, Actinium 228 (Gamma Spectroscopy only).
7.0) U-238 is determined via secular equilibrium with its daughter, Thorium 234 (Gamma Spectroscopy only).
8.0) All gamma spectroscopy was performed utilizing high purity germanium detectors (**HPGe**).
9.0) ARS makes every attempt to match sample density to calibrated density; however, in some cases, it is not practical or possible to do so and data results may be affected (Gamma Spectroscopy only).
10.0) Gamma spectroscopy results are calculated values based on the **ORTEC®** GammaVision ENV32 Analysis Engine.

Method References:

1.0) **EPA 600/4-80-032**; Prescribed Procedures for the Measurements of Radioactivity in Drinking Water, August 1980.
2.0) Standard Methods for Examination of Water and Waste Water, 18th, 1992.
3.0) **EPA SW-846**; Test Methods for Evaluating Solid Waste, Third Edition, (9/86). (Updated through 1995).
4.0) **EPA 600/4/79-020**; Methods for Chemical Analysis of Water and Waste, March 1983.
5.0) HASL 300
6.0) **ARS-040**; An LCSD is not reported with this process. The criteria for the LCS/LCSD analysis for reproducibility have not been established for Low Level Tritium analysis. A prepared standard for Low Level Tritium has not been developed. As a result, the standard we use is based on the dilution of a verified conventional tritium standard. The volume required for Low Level Tritium analysis, in addition to the lack of an available Low Level Tritium standard, introduce variability into the LCS/LCSD analysis that does not represent the actual sample analysis. The preferred measure for reproducibility is to run a duplicate analysis of a sample.

Definitions:

1.0)	**ND**	Not detecteo above the detection limit (non-detect).
2.0)	**MDC**	(Minimum Detectable Concentration) minimum concentration of the analyte that ARS can detect utilizing the specific analysis
3.0)	**MBL**	Method Blank
4.0)	**DO**	Duplicate Original
5.0)	**DUP**	Method Duplicate
6.0)	**MS/MSD**	Matrix Spike/Matrix Spike Duplicate
7.0)	**S**	Spike
8.0)	**RS**	Reference Spike
9.0)	***SC**	Subcontracted out to another qualified laboratory
10.0)	**NR**	Not Referenced
11.0)	**N/A**	Not Applicable
12.0)	**	False Positive due to interference from _____
13.0)	**U**	Activity is below the MDC
14.0)	**LCS/LCSD**	Laboratory Control Standard/Laboratory Control Standard Duplicate
15.0)	**DLC**	Decision Level Concentration (ANSI N42.23) or critical level

Notes: ARS International assumes no liability for the use or interpretation of any analytical results provided other than the cost of the analysis itself. Reproduction of this report in less than full requires the written consent of the client.

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CHAIN-OF-CUSTODY RECORD

ITSI Gilbane
Ed Palser
Walnut Creek
(505) 400-4076 EXT: epalser@itsi.com

COC # HPSD1-0147

Gilbane

Project Name: HPSD1	Laboratory: AMERICAN RADIATION SERVICES (ARS), INC., PORT ALLEN, LA
Project Number: 07204.0004	Point of contact: Please insert point of contact, insert laboratory phone number, insert e-mail
WBS Code: 0058000	Ship to: Please add laboratory address

Comments:

Equipment:

Code	Matrix
SO	SOIL

Code	Container/Preservative
	1* 250 mL plastic jar,

	Sample ID	Matrix	Date	Time	Samp Init.	A01RM - Solid Pu-23940	A01RM - Solid Po-210	E900 - Gross Alpha & Beta	E901.1 - Solid Ra-226 and CS-137	E905.0 - Solid Sr-90 and Sr-T	GS186 - Ra-226 and CS-137 Screening	Location ID	Sample Type	Depth (ft bgs) Top	Depth (ft bgs) Bottom
	Event: Ship Berth Surveying					**Analytical Test Method**									
1	04SBD-14B1-001	SO	7/22/2014	0800		X	X	X	X	X	X	04SBD-14B1-001	N1	0.00	0.00
2	04SBD-14B2-001	SO	7/22/2014	0900		X	X	X	X	X	X	04SBD-14B2-001	N1	0.00	0.00
3	04SBD-14B3-001	SO	7/22/2014	0940		X	X	X	X	X	X	04SBD-14B3-001	N1	0.00	0.00
4	04SBD-14B4-001	SO	7/22/2014	0630		X	X	X	X	X	X	04SBD-14B4-001	N1	0.00	0.00
Cooler # 1		**Turnaround Time: 0 Days**													

* Composite sample as per Ed Paulser. JOT 7-24-14

Relinquished by: *(Signature)*	Date	Time
[signature]	07.23.2014	1400

Received by: *(Signature)*	Date	Time
[signature]	072314	1400

Shipping Date / Carrier / Airbill Number

Shipping Date: 7/23/2014

Recevied by Laboratory: *(Signature, Date, Time)* **& condition**

[signature] 7.24.14 @ 11.04 / gd. cond.